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# **Space Communications and Navigation (SCaN) Program**

## **Commercial & International Lunar Communications and Navigation (C&N) Studies: *Request for Industry Participation***

**Jim Schier/NASA HQ SCaN**

**8/15/2008**

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# Study Motivation – Science

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- **Science Mission Directorate proposed the International Lunar Network (ILN)**
  - Goal is 6-8 surface stations operating simultaneously
  - 12 March 2008 Kickoff opened participation to all national space agencies
  - Initial lunar surface stations in the geophysical network may launch as early as 2013



# Study Motivation – Exploration



- **Exploration Systems Mission Directorate studies to date have treated Communication & Navigation (C&N) as if entirely provided by NASA**
  - Lunar Architecture Team Phase 1 & 2 (2006-2007)
  - Constellation Architecture Team Lunar Surface Systems (CxAT LSS) (2008)
- **Initial *Altair* lunar lander test planned in 2019 followed by  $\geq 2$  missions/year**
- ***Vision for Space Exploration* & NASA Authorization Act of 2005 direction is to “promote international and commercial participation in exploration”**
  - Dr. Griffin committed NASA to provide “essential C&N”



# Looking for Wider Participation

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- **Combination of Science & Exploration plans offers a natural evolutionary path for Communications and Navigation capabilities**
  - **2010's: Initial support for increasing number of lower rate science stations scattered over near & far side**
  - **2020's: Expanded support for human missions with establishment of Lunar Outpost and sortie missions anywhere on Moon**
- **Both programs plan to incorporate major contributions from international partners**
- **Exploration plans to (& ILN may) benefit from commercial partners**
- ***To meet the needs of both Science & Exploration customers, SCaN wants to examine commercial & international opportunities for lunar C&N capabilities and/or services***

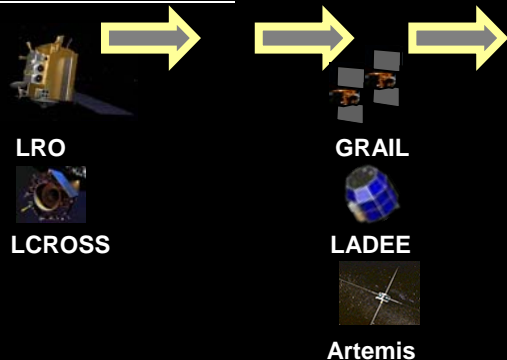


# Roadmap: Plans & Opportunities



2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021

## Science Missions



*Missions of Opportunity + International Coop.  
(Science-Funding & Opportunity Driven)*

**ILN Operation (Goal)**

*Possible International Partner Early Operations*



- *ILN Launch dates to be coordinated among ILN Partners to maximize number of simultaneous surface stations*



## Exploration Missions

## Space Communications and Navigation

### Interoperable Spectrum & Standards

- Strategy** ◆ ILN Strategy Agreement 12/2008
- Spectrum** ◆ ILN Spectrum Agreement
- Standards** ◆ ILN Standards Agreement ◆ ILN Stds Implemented ◆ Expl Phase 2 Standards Implemented ◆ Expl Phase 2.3 Standards?

Technology Flight  
Demos & Testbeds



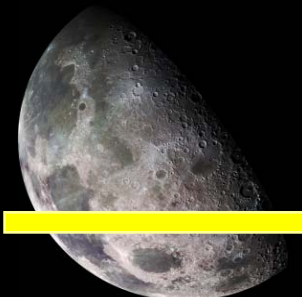
**ILN Relay  
Testbed**

**LRS  
Testbed**

- *ILN Relay needed 2013-2016 determined by need for far side ILN stations*

Operational Systems

**Lunar Relay  
Satellite (LRS)**





# Commercial Lunar C&N Study



- **First phase: Now – December 2008**
- **Purposes:**
  - Define “essential” C&N (a.k.a. ‘basic’ or ‘initial’) in sufficient detail to enable partitioning lunar C&N performance into the portion that NASA will supply and the portion that is eligible for commercial services;
  - Identify a range of C&N architecture options that employ commercial services including: terrestrial network services, Earth-based ground stations, Earth-orbiting assets, lunar orbiting assets, and lunar surface asset;
  - Assess potential market for commercial lunar C&N services with & without supportive strategy
  - Identify barriers to commercialization and ways to mitigate them;
  - Identify enablers of commercialization and ways to foster them;
  - Identify other recommendations that would contribute to a successful joint effort between NASA and industry to create a commercial lunar C&N market; and
  - Develop a recommended strategy for NASA to follow that will enable NASA to effectively and fairly evaluate commercial options and enable industry to collaborate in further architecture analysis and decisions. This strategy should address concerns from industry’s perspective such as business environment, profit, and business risk as well as NASA’s concerns.
  - Define plans for subsequent phase(s) of Lunar Commercial C&N Studies.



# Commercial Lunar C&N Study



- **Approach**
  - **Results of Lunar Architecture Team (LAT) study offered for background information**
    - Architecture decisions not expected until 2009-10 after factoring in external partnership, ESMD BAA results, & on-going studies
  - **Use RFI & workshops to solicit information from industry**
    - Industry asked to answer key questions contributing to determination of whether a commercial lunar C&N market could exist &, if so, how to establish it
    - No RFP planned  $\Rightarrow$  study defines strategy, not acquisition
  - **Conduct assessment of potential lunar C&N market**
    - Business as normal (NASA acquires whatever capability it needs)
    - If NASA/Industry jointly pursue strategies to foster commercial opportunities
  - **Hold workshops for industry & NASA to collaborate on strategy to enable commercialization**
  - **Prepare report on recommended strategies for NASA & Industry to pursue**



# Commercial Lunar C&N Study

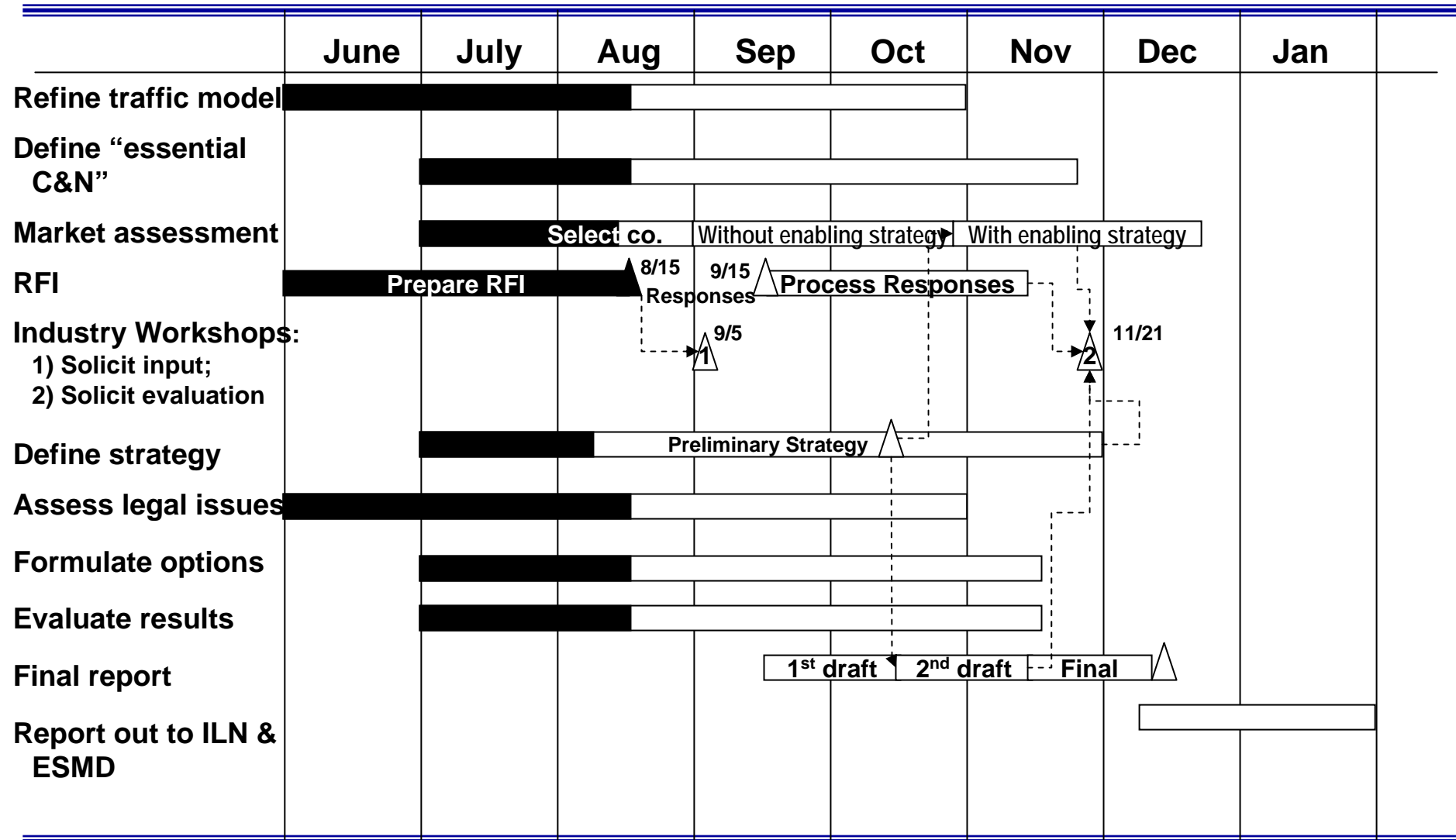


- **Participants:**
  - **Open to all who respond to RFI, i.e., all entities that want to explore possibilities of investing in lunar C&N**
    - **Open to foreign participation**
  - **Market assessment to be done by commercial firm with established industry reputation for independent market analysis**
    - **Market assessment results to be shared with industry to assist in building their business cases & talking to investors**
  - **Coordinating NASA responses across 4 programs in 3 Mission Directorates**
    - **CxP, COTS, ILN, & SCan programs in Exploration, Science, & Space Operations Mission Directorates**





# Near Term Plan – Commercial





# International Lunar C&N Study



- **First phase: Now – December 2008**
- **Purposes:**
  - **Establish Terms Of Reference (TOR) for ILN Communications approach**
  - **Establish means for coordinating international C&N needs to support ILN including**
    - **Spectrum**
    - **Standardized communication protocols**
    - **Standardized navigation services**
    - **Standardized data and networking protocols**
  - **Identify potential international contributions of C&N space & ground capabilities**
  - **Establish database of C&N needs for those ILN contributions identified this year**
  - **Establish framework for evolving interoperability from ILN in 2010's to Human Exploration in 2020's**



# International Lunar C&N Study

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- **Approach:**
  - **Use Interagency Operations Advisory Group (IOAG) for identification of needs**
    - Expand participation to all ILN partners
    - Use Space Internetworking Strategy Group (SISG) as technical WG to define Interoperability Roadmap
  - **Use Space Frequency Coordination Group (SFCG) to establish agreements on spectrum usage**
    - Spectrum architecture should be consistent for ILN & Exploration
  - **Use Consultative Committee on Space Data Systems (CCSDS) to establish roadmap for standards**
    - Standards architecture should evolve gracefully from ILN to Exploration
  - **Coordinate within NASA between Space Operations Mission Directorate's Space Communications and Navigation (SCaN) Office, Science MD (SMD), Exploration Systems MD (ESMD), and Office of External Relations on strategy & driving requirements**
  - **Coordinate with SMD Planetary Science Division's ILN Science Definition Team and Core Instrument Working Group**
  - **SCaN coordinates C&N needs across Science & Exploration and acts as NASA lead for external negotiations on C&N interoperability**
  - **Present final recommendations to Interoperability Plenary (IOP) #2 (Geneva, week of 12/8) & to ILN Partners (February)**



# International Lunar C&N Study

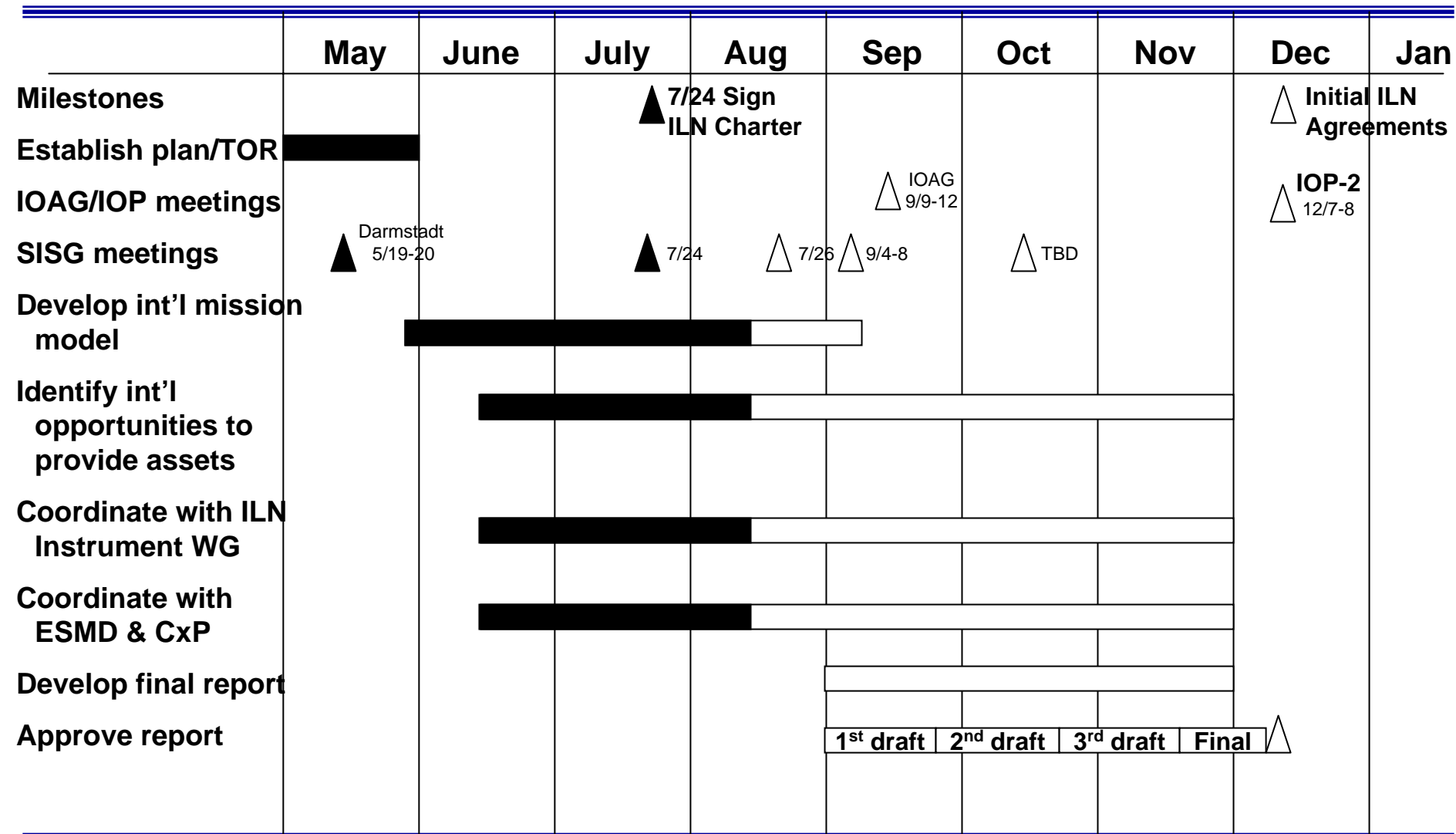
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- **Participants:**
  - **NASA:** SMD Planetary Science Division, SCan, OER, ESMD
  - **International:** All agencies that are signatories to the Global Exploration Strategy are invited to participate
    - Signatories of the ILN Statement of Intent are NASA, ASI, BNSC, CNES, CSA, DLR, ISRO, JAXA, & Korea



# Near Term Plan – International



# LAT2 C&N Focus Element Summary

## Overview

C&N services are provided via Relays & surface Lunar Comm Terminals (LCT) for the outpost with periodic Direct To Earth (DTE) capability. Relays cover entire lunar surface for sorties.

## Concept of Operations

There is redundant comm to Earth:

- Early missions via DTE and 1 relay
- Extended missions via DTE & 2 relays.

For surface operations, Outpost data is routed through the LCT to other lunar users or to Earth via DTE or LRS. LRS & LCT provide these services:

- Forward & return voice, video, data, & TT&C
- Fully routed data between Earth, lunar orbit, & lunar surface users
- 1 & 2-way ranging & Doppler tracking
- Surface Navigation Beacons
- Time dissemination & synchronization

## Lunar Relay Satellite

(LRS): Coverage of Outpost & rest of Moon with comm, tracking, & time services

**Ka Trunk to Earth**

**Tracking & Time services**

**Ka & S-band to Users**

**Ka & S-band DTE to Users when in view**

**LCT provides Outpost Wide Area Network & Beacon**

